F/NWR5

MEMORANDUM

November 24, 2004

FOR: FCRPS Remand File

FROM: Chris Ross and Rich Domingue

SUBJECT: FCRPS Effects on Adult Survival

In the FCRPS, salmon must pass up to eight mainstem dams. The cumulative loss for adults migrating up the Columbia and Snake rivers can be calculated as the difference in adult counts between dams (after adjustments for legal harvest and tributary turnoff). Adult loss, calculated this way, represents both mortality and apparent loss. Mortality can be related to passage through the dams and to other factors as well, such as illegal harvest, predation, gill-net interactions, and disease. Apparent adult loss between dams may be due to factors other than mortality, such as counting errors, double-counting adults that fall back and re-ascend ladders, and straying and tributary turnoff. A more reliable way to estimate adult passage loss is through the use of data from adult radio-tracking studies. This rules out the double-counting error associated with the dam count method, because it monitors the passage behavior of specific individual adults. Even with this method, however, many adult losses are not counted. For instance, there may not be any indication of a tagged adult's final fate except that it did not arrive at the next upstream dam. This unaccounted-for loss may be the result of mortality or straying and tributary turnoff, but it will not result from the counting errors inherent in the use of dam adult counts. The use of individually coded adult radio-telemetry tags greatly increases the precision associated with studies of adult migration behavior at dams and survival through the mainstem corridor (NMFS 2000).

While the final fate of many radio-tagged adults is uncertain, NOAA Fisheries considers the unaccounted-for adult loss estimate calculated from these studies to be more representative of the mortality rate associated with passage through the FCRPS dams than an adult loss estimate based on the comparison of adult counts between dams (NMFS 1995). Therefore, data from radio-tagging studies, when available, were used to estimate the unaccounted-for adult loss rate and, as a corollary, the minimum survival rates of adults passing through the hydrosystem. These estimates are considered minimums, because some radio-tagged adults that were considered dam-passage-caused mortalities in our analysis may have survived or suffered non-dam-caused fates. Minimum survival rates were derived by dividing the number of radio-tagged adults detected at an upstream dam by the number of adults tagged minus the number of fish accounted for in the study. Where multi-year study data are available for a particular species, the multiple-year results were averaged.

Keefer *et al.* (2004) focused on the fate of fish that reached the upstream end of the Bonneville Dam fishways in their study of adult conversions through the FCRPS, reasoning that fish that successfully ascended the Bonneville ladders did not suffer sampling mortality and were destined to spawn upstream from the dam. Thus, the effects of passing Bonneville Dam are not included in their report. To better estimate system survival including the effects of passing Bonneville Dam, we obtained additional data from that study, including the survival of known destination fish detected in Bonneville Dam's tailrace. In several instances, insufficient data are available from this study to identify the survival effects of Bonneville Dam. In those instances, other available data were used to estimate the Bonneville Dam passage survival rate (Keefer *et al.* 2002; Bjornn *et al.* 2000). The mean unaccountable loss rate in the multi-year reach studies, the mean minimal survival rates (1-loss), and the per-project survival rates for specific ESUs are shown in Table 1. The per-project survival rate was determined by assuming that each project imposes a similar influence on adult survival and taking the observed system survival value to the $1/n$ power, where n is the number of dams passed.[1] The assumption that each dam imposes similar survival stresses is not likely to be wholly correct, as it is known that pinniped predation in and near Bonneville Dam fishways amplifies the effect of delay there and that other dams, notably John Day Dam, have higher than average passage delays, suggesting a stronger passage survival effect. However, the generally high level of adult survival through the FCRPS suggests that this simplifying assumption does not greatly bias the results.

High per-project and system survivals indicate adult salmonid biological requirements are generally being met under current conditions. It is anticipated that biological requirements for migrating adult salmon and steelhead are met under the reference operation. NOAA Fisheries does not anticipate a substantial difference in adult salmon and steelhead survival rates between the proposed action and the reference operation.

[1] The data for UCR spring chinook, UCR steelhead, and SR sockeye are for Bonneville to Priest Rapids (Table 1). For tables in the Biological Opinion, the per project survival for Bonneville to Priest Rapids is applied only to FCRPS dams, Bonneville to McNary (UCR spring chinook, UCR steelhead), and Bonneville to Lower Granite (SR sockeye).

Table 1. Estimated minimum adult survival and unaccounted loss (Bonneville Dam Tailrace to top of John Day, Lower Granite, or Priest Rapids dams) based on radio-tracking studies of known-source fish through FCRPS projects. Source: Staff product (see footnotes).

	Adult Loss							Adult Survival		
	Radio Tracking Studies									
	1996	1997	1998	2000[8]	2001[8]	2002[8]	Mean Loss	Minimum Mean Survival[1]	Number of Dams	Per Project Survival[2]
Chinook Salmon										
SR spring/summer chinook [7]	0.184	0.173	0.153	0.250	0.064	0.102	0.154	0.846	8	0.979
SR fall chinook [7]			0.160	0.174	0.077	0.200	0.153	0.847	8	0.980
UCR spring chinook[7]				0.081	0.105	0.110	0.099	0.901	5	0.979[10]
LCR spring chinook[3]							0.035	0.965	1	0.965
LCR fall chinook[4]							0.020	0.980	1	0.980
Steelhead										
SR steelhead [7]	0.250	0.205			0.114	0.101	0.168	0.833	8	0.977
UCR steelhead [7]					0.097	0.048	0.073	0.928	5	0.985[10]
MCR steelhead[5]							0.067	0.933	3	0.977
LCR steelhead[6]							0.026	0.974	1	0.974
LCR coho[4]							0.020	0.980	1	0.980
SR sockeye salmon[9]		0.109					0.109	0.891	5	0.977

[1] 1 minus mean loss
[2] The nth root of the minimum survival estimate based on the number of dams (n) passed
[3] Bjornn et al. 2000
[4] From SR fall Chinook salmon per project survival rates
[5] From SR steelhead per project survival rates
[6] Keefer et al. 2002
[7] Data from ICFWRU, Memo of Aug. 11, 2004 (includes passage at Bonneville Dam)
[8] Ibid. Known Source Fish.
[9] Naughton et al. 2004 (in press); upper Columbia River sockeye.
[10] Data include Priest Rapids Dam

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